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Small business awareness and adoption of state-of-the-art technologies in emerging and developing markets, and lessons from the COVID-19 pandemic

Ikpe Justice Akpan^a , Elijah Abasifreke Paul Udoh^b and Bamidele Adebisi^c 

^aDepartment of Management & Information Systems, Kent State University, New Philadelphia, OH, USA; ^bMonetary Policy Department, Central Bank of Nigeria, Abuja, Nigeria; ^cSmart Infrastructure and Industry Research (SIIR) Group, Manchester Metropolitan University, Manchester, UK

ABSTRACT

Many challenges continue to hinder digital technologies' adoption by small and medium scale enterprises (SMEs) in developing economies. Comparatively, there are more success stories by SMEs in emerging markets. However, most SMEs operating in the informal sector in the emerging markets and developing economies (EMDEs) face similar challenges that inhibit the adoption of advanced technologies and innovations needed to improve business operations and re-engineer processes. This article evaluates the implementation and use of state-of-the-art technologies by SMEs in EMDEs to improve operations performance and create sustainable competitive advantages. Further, the papers in this Special Issue identify FinTech and analytical algorithms as some of the current technologies employed by SMEs in EMDEs to improve operations and processes in the manufacturing and service industries. The recognized technologies and technical innovations that seem novel in EMDEs have long existed in the advanced economies. Most state-of-the-art technologies, including cloud computing, 'big data', and predictive analytics that can improve operations and strategic decisions, are yet to make inroads in most EMDEs. Also, disruptive computing technologies, data analytics, and the Internet of Things (IoT) required to engineer new business models, reduce overheads, enhance competitive advantages, and digitize SMEs' business operations remain untapped. The absence and non-adoption of digital technologies in EMDEs explain why business activities in most EMDEs remain shut during the outbreak of SARS-CoV-2 and the community lockdown to contain the COVID-19 pandemic. The strategies to survive the 'new normal' imposed by COVID-19 and fierce global competition includes a successful adoption of advanced technologies.

RÉSUMÉ

De nombreux défis continuent d'entraver l'adoption des technologies numériques par les petites et les moyennes entreprises (PME) dans les économies en développement. En comparaison, les PME ont plus de succès dans les marchés émergents. Cependant, la plupart de celles qui opèrent dans le secteur informel des marchés émergents et des économies en développement (MEED)

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sont confrontées à des défis similaires qui entravent l'adoption des technologies avancées et des innovations nécessaires à l'amélioration des opérations commerciales et à la réorganisation des processus. Cet article évalue la mise en oeuvre et l'utilisation des technologies de pointe par les PME dans les MEED afin d'améliorer les opérations de performance et de créer des avantages concurrentiels durables. En outre, les articles de ce numéro spécial identifient FinTech et les algorithmes analytiques comme certaines des technologies actuellement utilisées par les PME dans les MEED pour améliorer les opérations et les processus dans les industries manufacturières et de services. Les technologies reconnues et les innovations techniques qui semblent nouvelles dans les MEED existent depuis longtemps dans les économies avancées. La plupart des technologies de pointe, y compris l'informatique en nuage, les « grosses données » et l'analyse prédictive qui peuvent améliorer les opérations et les décisions stratégiques, doivent encore faire leurs preuves dans la plupart des MEED. En outre, les technologies informatiques de rupture, l'analyse des données et l'Internet des objets (IdO), nécessaires à l'élaboration de nouveaux modèles commerciaux, à la réduction des frais généraux, au renforcement des avantages concurrentiels et à la numérisation des opérations commerciales des PME demeurent inexploités. L'absence et la non-adoption des technologies numériques dans les MEED expliquent pourquoi les activités commerciales dans la plupart de ces derniers restent interrompues pendant l'irruption du SRAS-CoV-2 et le confinement communautaire pour contenir la pandémie de COVID-19. Les stratégies pour survivre à la 'nouvelle normalité' imposée par le COVID-19 et la concurrence mondiale féroce comprennent l'adoption réussie des technologies avancées.

1. Introduction

The global business climate has become increasingly competitive and challenging in recent times, with small businesses often on the receiving end. The situation is notably more difficult in emerging markets and developing economies (EMDEs). The countries that make up the EMDEs come mainly from Africa, the Middle East, South East Asia, and South America (Gurtoo and Williams 2009; Warnecke 2016; Williams 2014). Most small businesses and local entrepreneurs in EMDEs tend to operate in the informal sector with limited funding and lack of human and social capital (Warnecke 2016; Ogunsade and Obembe 2016; Williams 2014). In some cases, the small and medium scale businesses (SMEs) in EMDEs are either unaware or lack the technical capabilities to implement the available state-of-the-art technologies (Abdullah 2002; Sookram and Watson 2008; Gurtoo and Williams 2009; Amiri and Woodside 2017). However, SMEs in these economies are gradually adopting the Internet and Web-related technologies to create social businesses and develop new business models (Venkatesh, Davis, and Morris 2007; Shaltoni 2017; Amiri and Woodside 2017; Omotosho 2020). Although these developments are improving the status quo, the systemic challenges in the EMDEs continue to inhibit the adoption and implementation of state-of-the-art technologies (Makiwa and Steyn 2018;

Omotosho 2020; Suyambu, Anand, and Janakirani 2020; Wollschlaeger, Sauter, and Jasperneite 2017). The revolution in Internet technologies and telecommunications provide new and affordable ways for SMEs in these economies to market products and promote brands (Omotosho 2020; Burke 2010; Abdullah 2002). However, technology adoption by small businesses in EMDEs is years behind the counterparts in the advanced economies (Makiwa and Steyn 2018; MacGregor and Kartiwi 2010).

Information Systems literature identifies several competitive forces that every business must overcome to enhance a sustainable competitive advantage and survival (Laudon and Laudon 2019; Mukhopadhyay, Kekre, and Kalathur 1995). The established competitive 'forces' include traditional competitors, new entrants that often penetrate the market with new zeal and advanced technologies that can dislodge the traditional market leaders, and the churning out of superior substitute products, of which examples abound as discussed elsewhere (McDonald and Eisenhardt 2020; Laudon and Laudon 2019). Others competitive forces are the customers' bargaining powers, and the suppliers empowered the more by the readily available information through the web-based marketplaces and online price comparison platforms in a globalized world (Laudon and Laudon 2019). While these challenges are not new, the fierceness and dimensions of the obstacles seem to take new dimensions due to rapid technological advancement in the globalized world (Liñán, Paul, and Fayolle 2019; Singh and Kumar 2020). For example, the rapid advancement in technology can lead to sudden changes in business models and often improve or re-engineer business processes. Globalization exposes the SMEs to fierce global competition, although it also offers a broader market and other hidden opportunities (Singh and Kumar 2020). Thus, the advances in technology can double as an enabler and the inhibitor of competitive forces. This implies that state-of-the-art technologies are a potent weapon to initiate and contend the competing forces (Laudon and Laudon 2019; Mukhopadhyay, Kekre, and Kalathur 1995).

Despite the competitive business environment, adopting state-of-the-art technology can help SMEs create new strategies and set the stage for long term growth and market leadership. The current technology revolution can benefit all businesses irrespective of the company size, industry, or operations activities. For example, social computing enables social business creation, social customer relationship management systems open new and low-cost communications channels (Laudon and Laudon 2019; Turkina 2018; Aceto, Persico, and Pescapé 2019). Similarly, virtual reality technology can help SMEs in developing and managing remote business operations and activities, in situations where direct contact is difficult or restricted, such as during the community lockdown to curtail the spread of the SARS-CoV-2 and the disease, COVID-19 (Akpan 2010; Laudon and Laudon 2019; Akpan and Shanker 2017; Akpan, Soopramanien, and Kwak 2020; Akpan and Brooks 2012; Smith et al. 2020).

Another potential benefit of adopting state-of-the-art technologies for SMEs is to enhance the digitization of internal operations and processes, improving performance effectiveness and efficiencies, re-engineering business models, and ensuring business survival (Laudon and Laudon 2019; Akpan, Soopramanien, and Kwak 2020). These benefits were utilized mainly by several SMEs in the advanced economies during the outbreak of COVID-19 pandemic and the resulting community lockdown to limit the spread and human-to-human transmission of the coronavirus disease (Papadopoulos, Baltas, and Balta 2020; Akpan, Soopramanien, and Kwak 2020). While the digitized

businesses in the advanced economies quickly moved to the virtual space, the SMEs in most EMDEs were under lock and key, with schools completely shut (Webster 2020; Lancet 2020; Akpan, Ezeume, et al. 2020; Peto et al. 2020). Thus, the development during the spread of COVID-19 global health problems has added impetus to the importance of technological innovation to enhance business operations and processes.

As the world prepares for the fourth industrial revolution, more state-of-the-art technologies are either created or enhanced, which SMEs can utilize to improve effective and efficient operations and performance, reduce risks, and achieve competitive advantages. Prominent among such advanced technologies include artificial intelligence, the Industrial Internet of Things (IIoT), and blockchain technologies to drive business activities and enhance business process innovation (Papadopoulos, Baltas, and Balta 2020; Sadiku et al. 2017; McKnight 2017; Lasi et al. 2014; Viriyasitavat et al. 2019).

Unlike the counterparts in the advanced economies, SMEs in EMDEs are yet to reap the full benefits of technological advancement due to several factors that tend to hinder the adoption of the available cutting-edge technologies. In an attempt to stimulate research on the subject, we issued a call for papers to evaluate the awareness and adoption of advanced technology and identify the apparent challenges against technology implementation and deployment by small businesses in EMDEs, including small firms that operate in the informal sector. The articles included in the Special Issue examine how simple technologies, such as FinTech, social media, and other technical innovations, improve small business operations and performance. However, there remain significant challenges against the adoption of state-of-the-art technologies by SMEs. At the same time, one of the papers examines the failed over-reliance on technological transfer as an impetus to revolutionizing and innovating operations and processes through foreign firms operating in EMDEs. The SMEs' inability to deploy cutting-edge technologies in EMDEs, such as virtual reality and cloud computing for remote operations and non-digitization of business activities, has negatively impacted firms operating in these countries during the ongoing COVID-19 pandemic and resulting community lockdown to contain the spread of SARS-CoV-2 (Attaran and Woods 2019; Akpan and Shanker 2019). This is in contrast with SMEs in advanced countries, where the firms immediately improvised technologies, and move the public and private sector businesses to the virtual space to keep the economies moving (Akpan, Soopramanien, and Kwak 2020; Papadopoulos, Baltas, and Balta 2020).

The rest of the paper is organized as follows. The next section presents an overview of the established and emerging state-of-the-art and disruptive technologies available for SMEs. Section three assesses the deployment and implementation of cutting-edge technologies by SMEs in EMDEs and summarizes the articles' synopsis in this Special Issue. Section four discusses the challenges facing SMEs in the deployment and implementation of cutting-edge technologies in EMDEs. Section five evaluates how a lack of adoption and use of advanced technologies has hampered SMEs' business operations during the ongoing COVID-19 global health crises. Finally, section six concludes the paper.

2. An overview of state-of-the-art technologies for businesses

This section presents an overview of several state-of-the-art technologies that small businesses can utilize to improve performance, enhance operations efficiency, and

create or sustain competitive advantage. Adopting these technologies can help to prepare SMEs in EMDEs to compete in the fourth industrial revolution (industry 4.0 or I4.0: Aceto, Persico, and Pescape 2019), and for survival in the current challenging economic and business environments and during crisis, such as the ongoing COVID-19 global health pandemic (Javaid et al. 2020; Akpan, Soopramanien, and Kwak 2020).

Internet and the web

The Internet is the bedrock of the I4.0 paradigm such that other enabling technologies depend on this digital communication infrastructure. The Internet allows for interaction among distributed humans and machines in I4.0 through global addressing and universal communication service (Aceto, Persico, and Pescape 2019; Lee and Knight 2005). The evolution of ethernet-based networks and wireless networks in digital communication has led to the emergence of IoT. Similarly, the proliferation of mobile personal communications and Wireless Local Area Network (WLAN) technologies has significantly reduced the cost of connecting mobile devices to the Internet (Wollschlaeger, Sauter, and Jasperneite 2017; Ande et al. 2020; Ikpehai et al. 2019). The noticeable rise of I4.0 has further fueled the migration to Internet Protocol Version 6 (IPv6) because of the need to identify and provide unique addresses for billions of cyber-physical systems. Thus, without the opportunities enabled by the Internet, the I4.0 paradigm would not differ from the scenario produced by the 3rd industrial revolution. In the absence of the Internet, a wide range of automation tools and devices, enabled by electronics and computing progress, would be forced to act as standalone pieces, thus widely limiting the opportunities provided by integration and interaction.

Industrial Internet of things

The vision of the Internet of Things (IoT) significantly overlaps with the I4.0 paradigm. Industrial IoT (IIoT) is the specific application of IoT to I4.0. IIoT refers to the connections of ‘machines, computers, and people enabling intelligent industrial operations for transformational business outcomes’ (Sadiku et al. 2017; Ande et al. 2020). At a basic level, IIoT can be summarized as sensor-equipped industrial machines connected through Internet technologies with other devices for, e.g., monitoring, analysis, and management. The implementation of this vision has profound consequences in technology, business organization, and markets, and comes with different opportunities and benefits including closed-loop design, increased consumer value, predictive maintenance, new service lines, and reduced labor cost (McKnight 2017; Lasi et al. 2014).

Cloud, edge, and fog computing

Cloud computing is a paradigm that enables the leasing of computing resources in real-time, with minimal interaction with the provider (Attaran and Woods 2019;

Bamiah, Brohi, and Chuprat 2012). Cloud computing simplifies operation and does not require a careful dimensioning and forecast of needed resources, allowing pay-per-use billing on a short-term basis, without upfront commitment. These increase resource utilization, allowing to implement economies of scale and keep costs low (Armbrust et al. 2010). Ultimately, the main drivers behind the adoption of cloud computing include the cost-saving, seamless implementation, and simplification (Sultan 2014; Beck et al. 2017). Different possibilities have been presented to leverage cloud computing flexibility for the goals of dynamism and efficiency (Thames and Schaefer 2016).

Big data analytics

Big data analytics is the technology designed to economically extract value from massive volumes of a wide variety of data by enabling high-velocity capture, discovery, and analysis (Chen, Mao, and Liu 2014; Hu et al. 2014). Online social network data is the traditional source of big data. Smart product-related information is the new source of big data that is specific to I4.0. The analysis of such data will fuel innovative and customer-centric post-sale services and provide feedback for better product design and marketing. Enterprise data will also increase the importance of big data analytics in I4.0. Already, there is a need to focus on business intelligence and related data mining to effectively face global competition and the foreseen spread of highly responsive decision-making based on data (Gantz and Reinsel 2011). Other sources of big data in I4.0 include precise control, continuous process improvement practice, and cyber-physical systems. Big data and predictive and visual analytics are critical enablers to aiding complex business decisions in the current challenging business environment (Akpan, Soopramanien, and Kwak 2020).

Artificial Intelligence

Artificial Intelligence (AI) involves learning, reasoning, and self-correction. AI perfectly fits with challenges arisen in typical I4.0 scenarios as it is required the use of knowledge-based and intelligent information approaches (Toro, Barandiaran, and Posada 2015). Deep Learning (DL) techniques are widely applied to smart manufacturing in I4.0 (Wang et al. 2018). Computer Vision is an essential enabling technology that sensibly enhances the outcomes, acting as a unifying element in many applications and a facilitator and integrator of other techniques (Posada et al. 2015). Cyber-physical equivalence is a promising research field. It aims to implement solutions for using fast-enough 3D-capture devices to acquire moving objects or articulated machinery and then streaming this 3D information into a virtual environment to facilitate planning tasks (Akpan and Brooks 2012). The technologies explained above and others including virtual reality, augmented reality, and digital twin can be deployed in various applications to extract data from sensors for analysis and visualization (Zhang et al. 2020; Akpan 2010; Dangelmaier et al. 2005; Akpan and Shanker 2017). This practice enhances design, manufacturing, and speed to market.

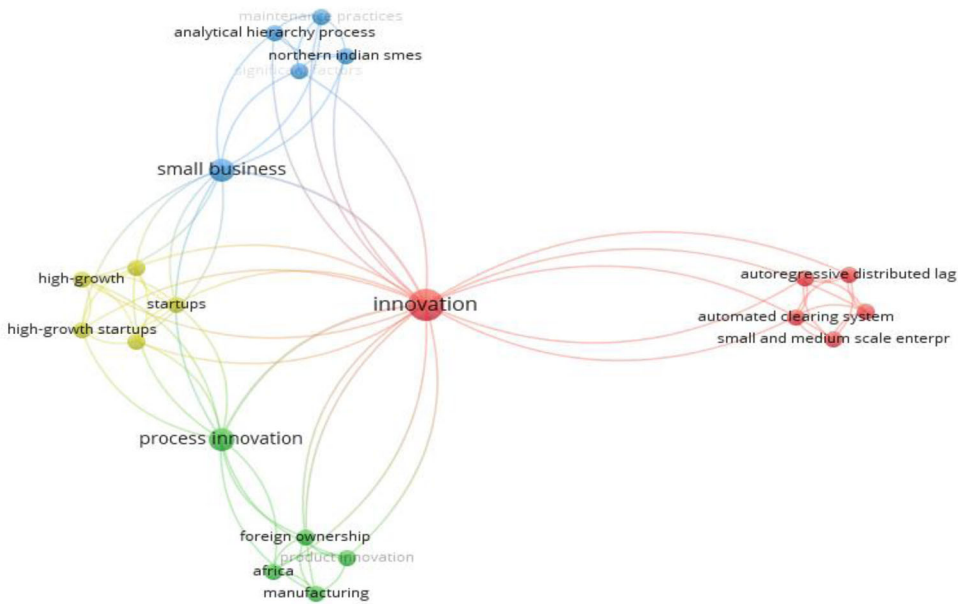


Figure 1. Network analysis of articles published in the special issue based on Author Keywords.

3. Implementation and adoption of state-of-the-art technologies and innovations by SMEs in EMDEs: a synopsis of the articles in the special issue

In June 2019, we issued a call for papers to stimulate scholarly research on the awareness, adoption, and implementation challenges of state-of-the-art technologies that can drive SMEs in EMDEs. The intention was to inspire investigations into identifying the essential technologies relevant and available to small businesses in EMDEs that can be employed to create and sustain strategic advantage, improve operations activities and processes, and ensure the growth and development of SMEs. We also intended to identify the challenges that inhibit the adoption of technology and innovations by SMEs in the EMDEs as the world prepares to launch the fourth industrial revolution (Masood and Sonntag 2020; Toro, Barandiaran, and Posada 2015).

This Special Issue contains four articles that address the small business awareness, adoption, and implementation of state-of-the-art technologies. This section summarizes the accepted articles for publication in this issue, which focuses on technology awareness, implementation, and adoption by SMEs in EMDEs. Figure 1 shows each article's highlights based on the specific theme and author keywords. The analysis that produces the results utilizes visual and network analysis. Further details of these analytic techniques discussed elsewhere (Liu et al. 2015; Akpan 2020; Akpan and Shanker 2017).

In each article which address different aspects of technology and innovation that impact SMEs in EMDEs, the authors explore the technological revolution and highlight the relationships, conflicts, and connections between different approaches, deepening the general view about the multidimensional nature of this revolution. The four articles offer a rich portrait of how the use of technologies by SMEs can dramatically

impact economic activities in the EMDEs. For example, the literature posits that technological innovation in the financial sector, popularly known as financial engineering, causes increased consumer credit to small businesses, improves effective demand, and value addition, leading to economic growth (Xin'e, Ting, and Yuan 2012).

The first article (Effiom and Edet 2020) investigates how technological innovation, such as on 'FinTech' improves the performance of SMEs. The study employs an 'autoregressive distributed lag methodology', to examine the effect that 'financial innovation', such as the 'automated clearing system', can have on 'SMEs' performance'. The labels shown on the five nodes on the right side of Figure 1 represent the author's keywords. The findings indicate that financial innovation can have a positive and significant effect on SMEs' productivity. In particular, some of the seven financial innovation instruments analyzed in the study include the automated teller machine (ATM), point of sales (POS), Web or Internet Banking, and mobile money operations that can improve SMEs' performance (Effiom and Edet 2020). Although some of these innovative technologies are well established in the advanced economies (e.g., ATM), the same is not the case in developing countries, where the adoption of such innovative platforms are considered novel (Effiom and Edet 2020).

The paper by Simranjit S. Sidhu, Kanwarpreet Singh, and I.P.S. Ahuja, develops an algorithm for ranking essential maintenance implementation dimensions. The article employs the combined analytical hierarchy process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach in Northern Indian SMEs. The highlight of the paper based on the author's keywords includes 'maintenance practices', 'analytical hierarchy process', 'technique for order preference by similarity to an ideal solution – TOPSIS', 'significant factors', and 'SMEs' (see the top of Figure 1). The authors deploy the AHP approach to calculate the weights, which serves as a primary input to TOPSIS for prioritizing the implementation dimensions for the successful implementation of maintenance practices. The analytical technique can also be utilized to determine efficient resource management of the production system and ensures operations at a required capacity. Implementing maintenance practices helps to carry out accurate predictive, preventive, and corrective actions, thus overcoming breakdowns and idle times. Where the SME is a supplier to other companies, it acts as the bedrock for efficient and smooth operation for the customer's organizations.

The third article entitled, 'Innovation characteristics of a high-growth startup: the case of Korean startups' is coauthored by Gil S. Jo and Pilseong Jang, which examines the innovation characteristics of high-growth startups by analyzing Korean Innovation Survey data with logit regression and decision tree models. The findings unequivocally show that process innovation is the most critical factor in creating high growth in startups. These results suggest that process innovation should be considered important when exploring innovation strategies for SMEs or designing support policies for startup growth.

The final article (Adu-Danso and Abbey 2020) addresses the common question of the validity or not of innovative technology transfer using data from 1157 manufacturing firms operating in Africa. The authors focused on two essential aspects of

manufacturing: products and processes innovation, as highlighted in [Figure 1](#). The study demonstrates that over-reliance on foreign-owned production SMEs operating in Africa to engineer the long-awaited and elusive innovative transformation in the process and product manufacturing in the continent. This conclusion provides a challenge for African technologists and scientists to look inward for technological breakthroughs rather than keep waiting for help that may never come from the advanced economies, hence the validity of the saying that the ‘patient dog may starve to death’ in this case.

The motivation for this special issue on technology awareness, adoption, and implementation of state-of-the-art technologies was to inspire researchers to understand the need to use digital technology by SMEs operating in the variate geographical, cultural, legal, economic, and political environments, especially in EMDEs. As the world prepares to welcome the fourth industrial revolution where the use of advanced technologies will hold sway, the gap between digitization of business activities in EMDEs and development need to be narrowed rather than widened between the developed and developing countries. While this intention remains, the outbreak of SARS-CoV-2 and COVID-19 further imposes the need to digitize and move business activities to the virtual space, reinforces the need to adopt state-of-the-art technologies as public health organizations continue to recommend social distancing to contain the spread of SARS-CoV-2.

4. Implementation challenges of state-of-the-art technologies by SMEs in emerging and developing markets

There is a wide gap between the developed and developing countries regarding the rate of adoption of advanced or state-of-the-art technologies by SMEs. One measure of such disparity of technology diffusion is the level of Internet penetration ([Akpan and Akpan 2017](#); [Kiiski and Pohjola 2002](#)). The rationale for utilizing the Internet penetration measure is owing to the essential nature of Internet technologies, which is central to the implementation of current technologies, such as social business creation, collaborative technologies, and the Internet of Things, and more ([Abdullah 2002](#); [Burke 2010](#); [Turkina 2018](#); [Omotosho 2020](#); [Papadopoulos, Baltas, and Balta 2020](#)), as discussed in Section two of this paper.

Although developing countries constitute a large proportion of the world population, the rate of internet usage and technological diffusion is quite low relative to the developed countries ([Akpan and Akpan 2017](#); [Berndt and Morrison 1995](#)). Data from the Internet World Stats indicate that Africa and Asia have the lowest level of internet penetration; even when the two regions jointly account for 72.3 per cent of world population ([Figure 2](#)). There is a vicious cycle where low rate of technological diffusion leads to lower productivity growth, loss of business opportunities and lower incomes, which in turn lead to further impediments to usage of latest technologies ([Brynjolfsson and Hitt 2000](#)).

Unlike SMEs in developed countries, where there is state of the art infrastructure and sound economic and political systems, many micro, medium scale and small enterprises in developing countries are confronted with challenges emanating from

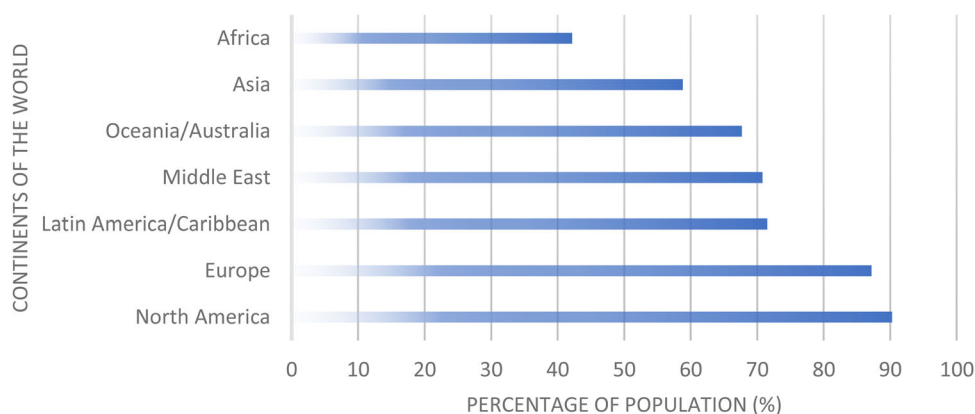


Figure 2. Internet penetration based on percentage per population (Data source: internetworldstats.com; accessed 25 August 2020).

the poor state of infrastructure and malfunctioning political and economic systems. As earlier state in this paper, the most power weapon of the fourth industrial revolution is the internet. The internet provides a veritable channel for the dissemination of technological knowledge across the globe. Unfortunately, a large portion of the developing countries are still cut off from the global village because of poor condition or limited availability of physical infrastructures to enable internet connectivity and usage. Furthermore, the absence of adequate communication network infrastructures and relatively high cost of equipment that is unafforded to a vast majority of the populace further compound the plight of developing countries and confine them to low connectivity and limited technological diffusion.

The problem is compounded by the lack of government interest and support in developing the infrastructures required to enhance internet connectivity either due to lack of the resources or poor vision to assign appropriate priority to technological innovation. Government has a role to play in the implementation and adoption of new technologies by SMEs. The strategic policy framework for acquisition and use of technology for social and economic development must be provided by the government. The slow pace of technological development in EMDEs is partly because of poor policy frameworks and insufficient public sector investment in the information and technology sector (Ejiaku 2014). Sometimes where the need and importance of investment in technology for development are well acknowledged, and a strategy developed, it is brought to abrupt end by political instability and change in government. Evidence of these abound in Africa and some Asian and Latin American countries.

Another aspect of the implementation challenges in developing countries is associated with technical capacity and skill development. In most emerging markets and developing economies (EMDEs), there is limited technical capacity and management support for internet connection. The dysfunctional educational system in most developing countries does not provide strong technical support for adoption of new technologies. Educational system that leaves learners with head or book knowledge without sufficient practical experience post a challenge to implementation of state-of-

the-art technologies by SMEs. This is worse in cases where the new technology comes with technical complexities that require some basic software and hardware skills.

In Africa and Asia, where the level of literacy is still low, ignorance of the relative advantages of state-of-the-art technology pose a challenge to adoption by SMEs. SMEs are more concerned about the security issues and risks associated with the new technologies, such as the fear of losing data, confusion over technical issues as well as the cost in terms of extra time and resources required to acquire the new technological skills.

5. Using state-of-the-art technologies for business operations and lessons from COVID-19 pandemic

The outbreak of SARS-CoV-2, the causative agent of the novel coronavirus disease, COVID-19, has caused significant disruptions to the operations activities and caused some modifications to the existing business models of SMEs worldwide (Huang et al. 2019; Akpan, Ezeume, et al. 2020; Akpan, Soopramanien, and Kwak 2020). As the world welcomes the 'new normal' resulting from the COVID-19, SMEs can utilize state-of-the-art technologies to digitize business activities and undertake virtual operations to enhance competitiveness, productivity, and business performance, and to ensure business survival (Akpan, Soopramanien, and Kwak 2020; Ting et al. 2020; CDC 2020; Papadopoulos, Baltas, and Balta 2020). Some of the applicable digital technologies include mobile and collaborative systems, Industrial Internet of Things (IIoT), and artificial intelligence as discussed in section two. For example, a significant shift in SMEs' business model due to COVID-19 is the deployment of virtual technologies for remote operations (Akpan, Soopramanien, and Kwak 2020). Ranging from educational activities to holding team meetings, organizing virtual events is soon becoming a new normal, a situation that will likely continue in the post-global health pandemic (Papadopoulos, Baltas, and Balta 2020).

The novel coronavirus (SARS-CoV-2) outbreak and the related disease (COVID-19) started in China with more than 80,000 confirmed cases (Huang et al. 2020). It was declared a global emergency and pandemic by the World Health Organization (WHO) on 11 March 2020 (Congressional Research Service 2020; Ting et al. 2020; Huang et al. 2019). Although the COVID-19 is not as fatal as other forms of virus diseases such as Ebola, SARS, and MERS, its most significant danger is its fast spread and ease of contagion (Mahase 2020). There are over 23 million SARS-CoV-2 confirmed infections and 810,000 deaths from COVID-19 as of August 25, 2020, (ECDC 2020; CDC 2020). Currently, the cases are fast increasing across the globe with the United States of America (USA) leading the list of infections and deaths with 5.09 million and 163,461, followed by Brazil with 3.06 million and 101,752, respectively. Other countries with a high number of confirmed COVID-19 infections include India (2.27 million), and the Russian Federation (892,654), according to the data from WHO reported by the EU center for disease control (ECDC 2020).

The WHO and medical experts have warned that the COVID-19 pandemic may not go away anytime soon. The COVID-19 pandemic has affected the global health condition and structure of economic order, pulling the global economy into recession. While the first concern is related to the security of public health, the impact on the

global economy and SMEs is enormous (Cowling, Brown, and Rocha 2020; Akpan, Soopramanien, and Kwak 2020; Juergensen, Guimón, and Narula 2020). IMF world economic outlook released on 24 June 2020, forecast a 4.9 percent decline in global GDP in 2020 with considerable downward risk. ILO projections are pointing toward a substantial rise in global unemployment (approximately between 5.3 million and 24.7 million), heralding difficult times ahead for the global economy, and the threat to the survival of SMEs (OECD 2020). In advanced economies like the USA, Germany, UK, and Canada, a significant percentage of small businesses have been severely hurt (OECD 2020; Juergensen, Guimón, and Narula 2020).

COVID-19 is dramatically changing our lives. In the absence of any vaccine and consensus medical protocol for the treatment of this sickness, the control measures adopted globally revolve around movement control, lockdown, confinement, and social distancing (Craven, Liu, and Mysore 2020). Some sectors have become more vulnerable, for instance, aviation, tourism, hotels, restaurants, entertainment with the highest disruptions to business while other industries such as food, healthcare, pharmaceutical, and information technology are less vulnerable (OECD 2020; Segal and Gerstel 2020; Ting et al. 2020). This 'new normal' calls for a change in business strategies, operations, and business conduct. SMEs must recognize and search for opportunities to reinvent themselves and develop new business strategies that are crucial to subdue the unique challenges confronting their survival (Syed 2019). Currently, a significant development so far is the switching of business operations by SMEs across the globe into online business due to the changes in consumers' purchase behavior during the lockdown and restrictions on movement. As common with technological revolutions, the unfolding events provide opportunities and threats, produce champions and casualties in EMDEs, and developed economies (Cowling, Brown, and Rocha 2020; Javaid et al. 2020; Akpan, Soopramanien, and Kwak 2020).

The global pandemic offers SMEs an opportunity to address the challenges inhibiting the adoption of new technologies. Given the low level of capitalization of most SMEs in developing countries, affordability of modern technologies is a key issue. The lockdown following the pandemic debar the inflow of foreign competitors and boost the demand for the products of the SMEs, especially in Agriculture, manufacturing, and food processing. Additional income earned can be utilized to acquire better technologies to further improve productivity and provide enhanced products and services. In addition, the absence of immediate substitutes and competitors offer the SMEs ample time to learn new skills, acquire experience and knowledge required to operate the new technologies. Furthermore, the most governments around the world including EMDEs are responding to the crisis with bailout funds, tax incentives and financial stimuli. The target of the funds is the vulnerable groups, which the SMEs account for a large proportion. Small businesses can utilize the financial support from the government to acquire new cutting-edge technologies to enhance operations activities.

6. Conclusion

As demonstrated in this study and the research carried out by authors of articles included in this Special Issue, recent developments in the global economy and the fiercely competitive business environments provide evidence that state-of-the-art

technologies are essential to enhancing competitive advantage and ensuring survival. Now that the world prepares to usher-in the fourth industrial revolution where technology and innovation will guide operations activities and dictate the pace, SMEs, despite limited financial capacity, can utilize the cloud computing option, which is now readily available for diverse Information Systems platforms. The cloud option requires little or no outlay, affordable, and can be deployed with minimal technical expertise. In addition, low costs technologies now exist that can help small businesses to undertake virtual operations in situations of community lockdown, such instances that occur during the COVID-19 pandemic (Hilfert and König 2016; Akpan, Shanker, and Razavi 2019; Dangelmaier et al. 2005; Akpan, Soopramanien, and Kwak 2020).

In the contemporary competitive business landscape, growing small businesses with smart cutting-edge technology can create and sustain competitive strategies and set the stage for long term growth and market leadership. Furthermore, the emergence of the current COVID-19 pandemic offers an opportunity for a resurgence of a new generation of entrepreneurs to lead the next industrial revolution and invent new ways of doing business by utilizing cutting-edge technology.

Future research needs to address ways to overcome the challenges hindering SMEs' adoption and implementation of digital technologies in EMDEs.

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Notes on contributors

Ikpe Justice Akpan is an Associate Professor of Information Systems at Kent State University, Ohio, USA. He holds a Ph.D. from Lancaster University, UK, specializing in computer simulation and virtual reality. Dr. Akpan serves as an Associate Editor for the Journal of Small Business and Entrepreneurship and has led two special issues as Guest Editor focusing on the application of advanced technologies in business. His research interests include computer simulation and applications, virtual reality, information visualization, and information systems strategies. He also employs operations research techniques, computer science, and information systems methods to solve problems in business, healthcare, and to address social issues that impact private and public organizations, families, and the society. His publications appear in *Decision Support Systems*, *Computers and Industrial Engineering*, *Journal of the Operational Research Society*, *Applied Energy*, and *Energy and Building*. His article in *Simulation* 95(2), won the Editors' Choice award in 2019. Dr. Akpan has taught at several universities across the world, including the United Kingdom, Canada, and the USA. He was appointed a distinguished visiting Professor of Information Systems at Shanghai International University, Shanghai, China, in 2016, and has also taught at Universities in Africa and the Middle East.

He recently served as Adjunct Professor in Information Systems discipline at Central China Normal University, Wuhan, China.

Elijah Abasifreke Paul Udoh, Ph.D., is a Principal Economist I, in the Fiscal Office of the Monetary Policy Department, Central Bank of Nigeria, Nigeria. He is a holder of PhD in Economics (specializing in International Trade and Public Sector Economics) from University of Ibadan, Ibadan, Nigeria. Before joining the Central Bank of Nigeria, he worked as a consultant at the West African Institute for Financial and Economic Management (WAIFEM). He also lectured for over 13 years at the Department of Economics, University of Calabar, Calabar, Nigeria where he rose to the rank of a Senior Lecturer in 2011; thereafter he resigned to join the Bank. His research works are published in peer-reviewed journals such as the *Journal of Economic Asymmetries*, *Journal of Developing Areas*, *Financial Innovation*, and *Journal of Business and Economics*.

Bamidele Adebisi, Ph.D. is a Professor of Intelligent Infrastructure Systems and Head of Smart Infrastructure and Industry Research (SIIR) Group, Manchester Metropolitan University, UK. He received Master's degree in advanced mobile communication engineering and Ph.D. in communication systems both from Lancaster University, UK. Between 2010 and 2012, he was a Work Package Leader of a successfully completed EU FP7 (agreement no. 247750)-smart grid Project. His research is mainly in embedding sensing, communication, control, and data analytic technologies in critical infrastructure, i.e. water, energy, transport (V2X/CAV), buildings etc. He publishes over 130 peer-review papers, and over 20 talks in the research areas of Internet of Things (IoT), artificial intelligence, machine learning, smart cities, smart grids, peer to peer energy trading and sharing, EVs, PLC/wireless communication and indoor solutions for energy and occupancy management. He has been part of multi-partner, multi-country projects as Principal Investigator and Co-Investigator. Examples include Innovate UK IoT for smart cities (£10M), EU H2020 project on Smart Cities (Triangulum) (€23M), EPSRC micro-grid for energy management (£700K), UK-S Korea-P2P Energy Trading & Sharing (£1M), UK-Canada -Energy IQ (£2.7M), etc. Bamidele is a member of IET, Senior member of IEEE, a Fellow of Higher Education Academy and a Chartered Engineer.

ORCID

Ikpe Justice Akpan  <http://orcid.org/0000-0002-3703-5704>

Bamidele Adebisi  <http://orcid.org/0000-0001-9071-9120>

References

- Abdullah, M. A. 2002. "Entrepreneurs and Their Influence on the Usage of Information Technology in SMEs: Evidence from Malaysia." *Journal of Small Business & Entrepreneurship* 16 (2): 60–76.
- Aceto, G., V. Persico, and A. Pescapé. 2019. "A Survey on Information and Communication Technologies for Industry 4.0: State-of-the-Art, Taxonomies, Perspectives, and Challenges." *IEEE Communications Surveys & Tutorials* 21: 3467–3501.
- Adu-Danso, E., and E. Abbey. 2020. "Does Foreign Ownership Enhance Technological Innovation Amongst Manufacturing Firms in Sub-Saharan Africa?" *Journal of Small Business & Entrepreneurship*. doi:10.1080/08276331.2020.1771813.
- Akpan, I. J. 2010. "Virtual Reality, 3D Visualization and Simulation in Decision Support." In *Strategic Advantage of Computing Information Systems in Enterprise Management*, edited by Majid Sarrafzadeh and Panagiotis Petratos, 13–44. Athens.
- Akpan, I. J., and R. J. Brooks. 2012. "Users' Perceptions of the Relative Costs and Benefits of 2D and 3D Visual Displays in Discrete-Event Simulation." *Simulation* 88 (4): 464–480.
- Akpan, I. J., and A. A. Akpan. 2017. The Impact of Internet Use on Students' learning Outcomes in Higher Education in Developing Countries. *International Journal of Education Research* 12 (1): 45–55.

- Akpan, I. J. 2020. "Scientometric Evaluation and Visual Analytics of the Scientific Literature Production on Entrepreneurship, Small Business Ventures, and Innovation." *Journal of Small Business & Entrepreneurship*, 1–29. doi:10.1080/08276331.2020.1786229.
- Akpan, I. J., I. C. Ezeume, E. Udomboso, A. Ezeume, and A. Akpan. 2020. "An Analysis of the Conceptual Structure of SARS-CoV-2 and COVID-19 Using Network Analysis and Visual Analytics." 1–23. doi:10.2139/ssrn.3593142.
- Akpan, I. J., D. Soopramanien, and D. H. A. Kwak. 2020. "Cutting-Edge Technologies for Small Business and Innovation in the Era of COVID-19 Global Health Pandemic." *Journal of Small Business & Entrepreneurship*, 1–11. doi:10.1080/08276331.2020.1799294.
- Akpan, I. J., and M. Shanker. 2017. "The Confirmed Realities and Myths about the Benefits and Costs of 3D Visualization and Virtual Reality in Discrete Event Modeling and Simulation: A Descriptive Meta-Analysis of Evidence from Research and Practice." *Computers & Industrial Engineering* 112: 197–211.
- Akpan, I. J., and M. Shanker. 2019. "A Comparative Evaluation of the Effectiveness of Virtual Reality, 3D Visualization and 2D Visual Interactive Simulation: An Exploratory Meta-Analysis." *Simulation* 95 (2): 145–170.
- Akpan, I. J., M. Shanker, and R. Razavi. 2019. "Improving the Success of Simulation Projects Using 3D Visualization and Virtual Reality." *Journal of the Operational Research Society*, 1–27. doi:10.1080/01605682.2019.1641649.
- Amiri, S., and J. M. Woodside. 2017. "Emerging Markets: The Impact of ICT on the Economy and Society." *Digital Policy, Regulation and Governance* 19 (5): 383–396..
- Ande, R., B. Adebisi, M. Hammoudeh, and J. Saleem. 2020. "Internet of Things: Evolution and Technologies from a Security Perspective." *Sustainable Cities and Society* 54: 101728.
- Armbrust, M., A. Fox, R. Griffith, A. D. Joseph, R. Katz, A. Konwinski, G. Lee, et al. 2010. "A View of Cloud Computing." *Communications of the ACM* 53 (4): 50–58.
- Attaran, M., and J. Woods. 2019. "Cloud Computing Technology: Improving Small Business Performance Using the Internet." *Journal of Small Business & Entrepreneurship* 31 (6): 495–519.
- Bamiah, M., S. Brohi, and S. Chuprat. 2012. "A Study on Significance of Adopting Cloud Computing Paradigm in Healthcare Sector." 2012 International Conference on Cloud Computing Technologies, Applications and Management (ICCCTAM), 65–68. Dubai, United Arab Emirates, December 8–10.
- Beck, R., M. Avital, M. Rossi, and J. B. Thatcher. 2017. "Blockchain Technology in Business and Information Systems Research." *Business & Information Systems Engineering* 59 (6): 381–384..
- Berndt, E., and C. Morrison. 1995. "High-Tech Capital Formation and Economic Performance in U.S. Manufacturing Industries: An Exploratory Analysis." *Journal of Econometrics* 65 (1): 9–43.
- Brynjolfsson, E., and L. Hitt. 2000. "Beyond Computation: Information Technology, Organizational Transformation and Business Performance." *Journal of Economic Perspectives* 14 (4): 23–48.
- Burke, K. 2010. "The Impact of Internet and ICT Use among SME Agribusiness Growers and Producers." *Journal of Small Business & Entrepreneurship* 23 (2): 173–194.
- Centers for Disease Control and Prevention (CDC). 2020. "Coronavirus Disease 2019 (COVID-19)." Atlanta: CDC. <https://www.cdc.gov/coronavirus/2019-ncov/about/symptoms.html>
- Chen, M., S. Mao, and Y. Liu. 2014. "Big Data: A Survey." *Mobile Networks and Applications* 19 (2): 171–209.
- Congressional Research Service. 2020. "Global Economic Effects of Covid-19." Downloaded from <https://fas.org/sgp/crs>
- Cowling, M., R. Brown, and A. Rocha. 2020. "Did You save Some Cash for a Rainy COVID-19 Day? The Crisis and SMEs." *International Small Business Journal*: 1–12. doi:10.1177/0266242620945102.
- Craven, M., L. Liu, and M. Mysore. and Wilson, M. 2020. COVID-19: Implications for Business. Executive Briefing, COVID-19: Briefing NTE, McKinsey & Company. Downloaded from <https://www.mckinsey.com/business-functions/risk/our-insights>

- Dangelmaier, W., M. Fischer, J. Gausemeier, M. Grafe, C. Matysczok, and B. Mueck. 2005. "Virtual and Augmented Reality Support for Discrete Manufacturing System Simulation." *Computers in Industry* 56 (4): 371–383.
- Effiom, L., and S. E. Edet. 2020. "Financial Innovation and the Performance of Small and Medium Scale Enterprises in Nigeria." *Journal of Small Business & Entrepreneurship*: 1–34. doi:10.1080/08276331.2020.1779559.
- Ejiaku, S. A. 2014. "Technology Adoption: Issues and Challenges in Information Technology Adoption in Emerging Economies." *Journal of International Technology and Information Management* 23 (2): 59–68. <https://scholarworks.lib.csusb.edu/jitim/vol23/iss2/5>
- European Centre for Disease Prevention and Control (ECDC). 2020. "COVID-19. Situation Update Worldwide." Stockholm: ECDC. Accessed August 11 2020. <https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide>
- Gantz, J., and D. Reinsel. 2011. "Extracting Value from Chaos." *IDC Iview* 1142: 1–12.
- Gurtoo, A., and C. C. Williams. 2009. "Entrepreneurship and the Informal Sector: Some Lessons from India." *The International Journal of Entrepreneurship and Innovation* 10 (1): 55–62.
- Hilfert, T., and M. König. 2016. "Low-Cost Virtual Reality Environment for Engineering and Construction." *Visualization in Engineering* 4 (1): 2.
- Hu, H., Y. Wen, T.-S. Chua, and X. Li. 2014. "Toward Scalable Systems for Big Data Analytics: A Technology Tutorial." *IEEE Access* 2: 652–687.
- Huang, C., Y. Wang, X. Li, L. Ren, J. Zhao, Y. Hu, L. Zhang, et al. 2020. "Clinical Features of Patients Infected with 2019 Novel Coronavirus in Wuhan, China." *The Lancet* 395 (10223): 497–506.
- Huang, J., L. Kong, G. Chen, M.-Y. Wu, X. Liu, and P. Zeng. 2019. "Towards Secure Industrial IoT: Blockchain System with Credit-Based Consensus Mechanism." *IEEE Transactions on Industrial Informatics* 15 (6): 3680–3689.
- Humphries, J. E., C. Neilson, and G. Ulyssea. 2020. "The Evolving Impacts of COVID-19 on Small Businesses since the CARES Act (April)." Cowles Foundation Discussion Paper No. 2230. doi:10.2139/ssrn.3584745.
- Ikpèhai, A., B. Adebisi, K. M. Rabie, K. Anoh, R. E. Ande, M. Hammoudeh, H. Gacanin, and U. M. Mbanaso. 2019. "Low-Power Wide Area Network Technologies for Internet-of-Things: A Comparative Review." *IEEE Internet of Things Journal* 6 (2): 2225–2240.
- ILO. 2020. "COVID-19 and the World of Work: Impact and Policy Responses." ILO Monitor, 1st Edition. March 18, 2020. Downloadable at <https://www.ilo.org/global/topics/coronavirus>
- IMF. 2020. "IMF World Economic Outlook." June 2020. Downloadable from <https://www.imf.org/en/publications/weo/issues/2020/06/24/weo-june-2020>
- Javaid, M., A. Haleem, R. Vaishya, S. Bahl, R. Suman, and A. Vaish. 2020. "Industry 4.0 Technologies and Their Applications in Fighting COVID-19 Pandemic." *Diabetes & Metabolic Syndrome* 14 (4): 419–422.
- Juergensen, J., J. Guimón, and R. Narula. 2020. "European SMEs Amidst the COVID-19 Crisis: Assessing Impact and Policy Responses." *Journal of Industrial and Business Economics*, 47: 499–510. doi:10.1007/s40812-020-00169-4.
- Kiiski, S., and M. Pohjola. 2002. "Cross-Country Diffusion of the Internet." *Information Economics and Policy* 14 (2): 297–310.
- Lancet, T. 2020. "India under COVID-19 Lockdown." *Lancet* 395 (10233): 1315.
- Lasi, H., P. Fettke, H. Kemper, T. Feld, and M. Hoffmann. 2014. "Industry 4.0." *Business & Information Systems Engineering* 6 (4): 239–242.
- Laudon, K. C., and J. P. Laudon. 2019. *Management Information Systems: Managing the Digital Firm*. 16th ed. Harlow, UK: Pearson Education Limited.
- Lee, C. S., and D. Knight. 2005. "Realization of the Next-Generation Network." *IEEE Communications Magazine* 43: 34–41.
- Liñán, F., J. Paul, and A. Fayolle. 2019. "SMEs and Entrepreneurship in the Era of Globalization: Advances and Theoretical Approaches." *Small Business Economics*, 55: 695–703.

- Liu, W., G. Hu, L. Tang, and Y. Wang. 2015. "China's Global Growth in Social Science Research: Uncovering Evidence from Bibliometric Analyses of SSCI Publications (1978–2013)." *Journal of Informetrics* 9 (3): 555–569.
- MacGregor, R. C., and M. Kartiwi. 2010. "Perception of Barriers to e-Commerce Adoption in SMEs in a Developed and Developing Country: A Comparison between Australia and Indonesia." *Journal of Electronic Commerce in Organizations* 8 (1): 61–82.
- Mahase, E. 2020. "Coronavirus: Covid-19 Has Killed More People than SARS and MERS Combined, Despite Lower Case Fatality Rate." *BMJ* 368. doi:[10.1136/bmj.m641](https://doi.org/10.1136/bmj.m641).
- Makiwa, P., and R. Steyn. 2018. "An Investigation of the Government-Related Factors That Inhibit Small to Medium Enterprises' Adoption and Effective Use of Information and Communication Technology in Developing Countries: The Case of Zimbabwe." In *International Development Informatics Association Conference*, Springer, Cham, 3–16.
- Masood, T., and P. Sonntag. 2020. "Industry 4.0: Adoption Challenges and Benefits for SMEs." *Computers in Industry* 121: 103261.
- McDonald, R. M., and K. M. Eisenhardt. 2020. "Parallel Play: Startups, Nascent Markets, and Effective Business-Model Design." *Administrative Science Quarterly* 65 (2): 483–523.
- McKnight, M. 2017. "IoT, Industry 4.0, Industrial IoT... Why Connected Devices Are the Future of Design." *KnE Engineering* 2 (2): 197–202.
- Mukhopadhyay, T., S. Kekre, and S. Kalathur. 1995. "Business Value of Information Technology: A Study of Electronic Data Interchange." *MIS Quarterly* 19 (2): 137–156.
- OECD. 2020. "New OECD Outlook on the Global Economy." Downloadable from <https://www.oecd.org/coronavirus>
- OECD. 2020. "OECD: Tackling Coronavirus (COVID-19): Contributing to a Global Effort." Downloaded from <https://www.read.oecd-ilibrary.org>
- Ogunsade, I. A., and D. Obembe. 2016. "The Influence of Informal Institutions on Informal Sector Entrepreneurship: A Study of Nigeria's Hand-Woven Textile Industry." *Journal of Small Business & Entrepreneurship* 28 (6): 413–429.
- Omotosho, B. J. 2020. "Small Scale Craft Workers and the Use of Social Media Platforms for Business Performance in Southwest Nigeria." *Journal of Small Business & Entrepreneurship*: 1–16. doi:[10.1080/08276331.2020.1764732](https://doi.org/10.1080/08276331.2020.1764732).
- Papadopoulos, T., K. N. Baltas, and M. E. Balta. 2020. "The Use of Digital Technologies by Small and Medium Enterprises during COVID-19: Implications for Theory and Practice." *International Journal of Information Management*, 1–4. doi:[10.1016/j.ijinfomgt.2020.102192](https://doi.org/10.1016/j.ijinfomgt.2020.102192).
- Peto, J., N. A. Alwan, K. M. Godfrey, R. A. Burgess, D. J. Hunter, E. Riboli, P. Romer, et al. 2020. "Universal Weekly Testing as the UK COVID-19 Lockdown Exit Strategy." *The Lancet* 395 (10234): 1420–1421.
- Posada, J., C. Toro, I. Barandiaran, D. Oyarzun, D. Stricker, R. de Amicis, E. B. Pinto, P. Eisert, J. Döllner, and I. Vallarino. 2015. "Visual Computing as a Key Enabling Technology for Industrie 4.0 and Industrial Internet." *IEEE Computer Graphics and Applications* 35 (2): 26–40.
- Sadiku, M. N., Y. Wang, S. Cui, and S. M. Musa. 2017. "Industrial Internet of Things." *International Journal of Advances in Scientific Research and Engineering* 3: 1–4.
- Segal, S., and D. Gerstel. 2020. "The Global Economic Impacts of COVID-19, Critical Questions, Center for Strategic and International Studies (CSIS)." Downloadable from <https://www.csis.org/analysis>
- Shaltoni, A. M. 2017. "From Websites to Social Media: Exploring the Adoption of Internet Marketing in Emerging Industrial Markets." *Journal of Business & Industrial Marketing* 32 (7): 1009–1019.
- Singh, R. K., and R. Kumar. 2020. "Strategic Issues in Supply Chain Management of Indian SMEs Due to Globalization: An Empirical Study." *Benchmarking: An International Journal* 27 (3): 913–932..
- Smith, A. C., E. Thomas, C. L. Snoswell, H. Haydon, A. Mehrotra, J. Clemensen, and L. J. Caffery. 2020. "Telehealth for Global Emergencies: Implications for Coronavirus Disease 2019 (COVID-19)." *Journal of Telemedicine and Telecare* 26 (5): 309–313.

- Sookram, S., and P. K. Watson. 2008. "Small-Business Participation in the Informal Sector of an Emerging Economy." *The Journal of Development Studies* 44 (10): 1531–1553.
- Sultan, N. 2014. "Making Use of Cloud Computing for Healthcare Provision: Opportunities and Challenges." *International Journal of Information Management* 34 (2): 177–184.
- Suyambu, G. T., M. Anand, and M. Janakirani. 2020. "Blockchain—A Most Disruptive Technology on the Spotlight of World Engineering Education Paradigm." *Procedia Computer Science* 172: 152–158.
- Syed, H. A. (2019). Sustainability in Crisis: Towards Business Continuity in Small and Medium Enterprises. In Proceedings of the 17th European Conference on computer-Supported cooperative work: The International Venue on Practice-centred Computing and the Design of Cooperative Technologies – Doctoral Colloquium Papers, Reports of the European Society for Socially Embedded Technologies. doi: [10.18420/ecscw2019_dc10](https://doi.org/10.18420/ecscw2019_dc10).
- Thames, L., and D. Schaefer. 2016. "Software-Defined Cloud Manufacturing for Industry 4.0." *Procedia Cirp* 52: 12–17.
- Ting, D. S. W., L. Carin, V. Dzau, and T. Y. Wong. 2020. "Digital Technology and COVID-19." *Nature Medicine* 26 (4): 459–461.
- Toro, C., I. Barandiaran, and J. Posada. 2015. "A Perspective on Knowledge Based and Intelligent Systems Implementation in Industrie 4.0." *Procedia Computer Science* 60: 362–370.
- Turkina, E. 2018. "The Importance of Networking to Entrepreneurship: Montreal's Artificial Intelligence Cluster and Its Born-Global Firm Element AI." *Journal of Small Business & Entrepreneurship* 30 (1): 1–18.
- Vaccaro, A. R., C. L. Getz, B. E. Cohen, B. J. Cole, and C. J. Donnelly, III. 2020. "Practice Management during the COVID-19 Pandemic." *The Journal of the American Academy of Orthopaedic Surgeons* 28 (11): 464–470.
- Venkatesh, V., F. Davis, and M. G. Morris. 2007. "Dead or Alive? The Development, Trajectory and Future of Technology Adoption Research." *Journal of the Association for Information Systems* 8 (4): 267–286.
- Viriyasitavat, W., L. Da Xu, Z. Bi, and V. Pungpapong. 2019. "Blockchain and Internet of Things for Modern Business Process in Digital Economy—The State of the Art." *IEEE Transactions on Computational Social Systems* 6 (6): 1420–1432.
- Wan, J., S. Tang, Z. Shu, D. Li, S. Wang, and M. Imran. 2016. "Software-Defined Industrial Internet of Things in the Context of Industry 4.0." *IEEE Sensors Journal* 16: 7373–7380.
- Wang, J., Y. Ma, L. Zhang, R. X. Gao, and D. Wu. 2018. "Deep Learning for Smart Manufacturing: Methods and Applications." *Journal of Manufacturing Systems* 48: 144–156.
- Warnecke, T. 2016. "Informal Sector Entrepreneurship for Women in China and India: Building Networks, Gaining Recognition, and Obtaining Support." *Journal of Small Business & Entrepreneurship* 28 (6): 479–491.
- Webster, P. 2020. "Virtual Health Care in the Era of COVID-19." *The Lancet* 395 (10231): 1180–1181.
- Williams, C. C. 2014. "Explaining Cross-National Variations in the Commonality of Informal Sector Entrepreneurship: An Exploratory Analysis of 38 Emerging Economies." *Journal of Small Business & Entrepreneurship* 27 (2): 191–212.
- Wollschlaeger, M., T. Sauter, and J. Jasperneite. 2017. "The Future of Industrial Communication: Automation Networks in the Era of the Internet of Things and Industry 4.0." *IEEE Industrial Electronics Magazine* 11 (1): 17–27.
- Xin'e, Z., W. Ting, and Z. Yuan, Z. 2012. Economic Value Added for Performance Evaluation: A Financial Engineering. *Systems Engineering Procedia* 5: 379–387. doi:[10.1016/j.sepro.2012.04.059](https://doi.org/10.1016/j.sepro.2012.04.059).
- Zhang, C., G. Zhou, H. Li, and Y. Cao. 2020. "Manufacturing Blockchain of Things for the Configuration of a Data-and Knowledge-Driven Digital Twin Manufacturing Cell." *IEEE Internet of Things Journal*. 1–12. doi:[10.1109/JIOT.2020.3005729](https://doi.org/10.1109/JIOT.2020.3005729).